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INFLUENCE OF PRIOR CONTENT EXPLOITATION VIA THE M@T-EDUCATE WITH SUCCESS PLATFORM IN STUDENT LEARNING

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Institutions of higher education driven by contemporary society, influenced by constant technological, social, political and economic changes, have as main mission is to prepare citizens able to meet the demands of this society. In this sense, educational contexts should be more focused on student learning, promoting more autonomous and more active citizens. Current technologies, especially online, constitute an asset in pursuit of these objectives. Several studies point to the importance of online environments in students' learning process as well as enable them to make the management of both learning mechanisms in formal and informal context, allowing them to develop skills of autonomy.

One area that can most benefit from these environments is mathematics that, despite its importance, continues to merit the concern of various entities by being one of the generators of educational and academic failure.

This study aims to evaluate the influence of previous exploration of mathematical content, before being covered in the classroom by M@T educate with success platform in the development of mathematical knowledge and skills, autonomy and interest in this area amongst higher education students.

The study took place in the course of Calculus from the Degree in Management from a Portuguese polytechnic institution.

Methodologically we opted for a mixed research approach and designed a case study, since it allows to study, in detail, a particular problem. Various techniques of data collection were used, such as, inquiry, observation and document analysis, supported by various instruments.

Data statistical and content analysis allows to conclude that the prior exploration of content through the platform contributes mainly to the development of autonomy and the ability to apply the knowledge produced to solve tasks of different nature.

keywords: virtual learning environments, platform m-@t educate with success, higher education, mathematics learning, autonomy.

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Abstract

Institutions of higher education driven by contemporary society, influenced by constant technological, social, political and economic changes, have as main mission is to prepare citizens able to meet the demands of this society. In this sense, educational contexts should be more focused on student learning, promoting more autonomous and more active citizens. Current technologies, especially online, constitute an asset in pursuit of these objectives. Several studies point to the importance of online environments in students' learning process as well as enable them to make the management of both learning mechanisms in formal and informal context, allowing them to develop skills of autonomy.

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Keywords: Virtual Learning Environments, Platform M@t-educate with success, Higher Education, Mathematics Learning, Autonomy.

1 INTRODUCTION

Due to constant economic and technological developments the world, we live in a context of gradual and irreversible globalization [1], which sets the context to the Bologna Process.

This process was a milestone in the higher education system, having driven the shift from a system where the focus lies on the teacher to a student-centred one [2], able to promote the development of skills such as autonomy and personal, critical and responsible work that will allow students to meet current and future demands of society. The teacher has to encourage, in particular, the rediscovery, imagination and creativity of students and promote lifelong learning.

The importance of mathematics is recognized in the lives of citizens and in their training [3] as part of the curriculum of many university courses. However, school failure in this area is also a reality in this educational context [4], [5]. This has been the focus of international research and several studies have shown that Information and Communication Technologies can play a key role in driving change in the teaching and learning of mathematics [5], [6], [7], [8].

Aiming to contribute to increase the academic success in mathematics, in an innovative way, Platform M@t-educate with success (pM@T) [9] platform was created as a supportive environment for the

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learning of mathematics. However this environment lacks in review and that is the core theme of this study.

With this research, we intend to evaluate the influence of previous exploration of content on student learning, through the pM@T platform.

This paper focuses mainly on the influence of pM@T platform in the development of mathematical skills, requiring the mobilization of knowledge skills, such as autonomy, and attitudes as related to the interest expressed by students, regarding to mathematics. Initially, we seek to frame and support the study, theoretical and methodologically. Then, we present the main results and conclusions that have been reached.

2 THEORETICAL FRAMEWORK

2.1 Higher education and the knowledge society

Since the end of the 20th century, various technological, economic and social changes have interfered in society, causing changes in the world as in the way we communicate, think and understand. We live in an irreversible phenomenon of "globalization" [1], without losing sight of the local identity. The Information Society [10], supported by the storage and data transmission technologies, evolved into Information and Communication Society [11], in which we can establish communications increasingly favourable conditions for the quantity, speed and reliability. But presently, it is desired that it may constitute a true knowledge society [1]. Indeed, knowledge is now considered a pillar of the wealth and power of nations, playing a central role in contemporary society, more and more competitive and dynamic [12] – what is the truth today may no longer be tomorrow – and its evolution is not just an extension of knowledge, but it will be built with constant changes and ruptures. In this context, UE aims to turn Europe into the "most competitive and dynamic economy in the world" [13]. To achieve that, quality education for all is essential, based on the ideals of a democratic society, with a humanistic orientation, which upholds principles of equality, rationality and social justice. And, it recognizes the importance of higher education institutions as centres of excellence of knowledge, which should take an active role in economic, social and political development at the European level. In this framework, Bologna process was developed as a driver of the construction of the European Higher Education Area, towards the promotion of European cohesion. It has brought multiple changes, at curricular organization and at the pedagogical and methodological levels [14]. Regarding the structure of the educational offer, undergraduate, masters and doctoral programs were unified. On the other hand, it was encouraged to change an educational system based on "transmission of knowledge" in which the teacher was the centre of the educational process. It is argued now, the importance of a system where the student is (co) responsible for (co) construction of their own knowledge [12]. Learning becomes the centre of the educational process [2], the teacher having a key role as advisor and facilitator of this process. Thus, it helps the student to acquire and develop personal, social and professional skills, essential to their future. The student should be therefore provided with the necessary skills to continue learning throughout life, in the context of continuous change and innovation. In other words, higher education should be more focused on student learning, promoting more active and more autonomous learners, able to understand the world where they live in, to use the information with a critical sense and make sustainable choices in educational contexts. [16]. Thus, on the one hand, higher education contributes to the development of technologies which have spurred changes in contemporary society, on the other hand, to enjoy this development cannot disregard the constant change, evolving technologies and their implications on society.

2.2 Online technologies and Maths learning

It is increasingly a reality the presence of technology in schools, for example as a means of communication between faculty, students and staff, through the support of disciplines enrolment and the disclosure of students' grades [17]. At the school level, the Information and Communication Technologies (ICT) can be studied from various disciplines of the curriculum, in order: (i) to support learning in the classroom; (ii) to provide opportunities for self-study based on electronic documents; (iii) to simplify the development of training systems at distance; (iv) to virtually extend the classroom; (v) to generate new online training ways [18]. Its use is also found often involved in the creation of richer learning environments that are characterized by greater sharing, collaboration, communication and participation [19], which can transform how students learn, use, and build knowledge [20]. Thus, and according to several authors [21], [22], [23], the adoption of technologies provides greater

participation , collaboration and interaction among students in learning scenarios, making them more active, fostering new forms of learning. Several authors point to a significant improvement in the performance and attitudes of students, in relation to their learning, when digital technology is integrated in the learning process [24], [25]. In this sense, technology can facilitate more effectively the construction of knowledge in higher education [26] and at any place and any time, requiring to students more autonomy and independence.

Mathematics is considered as the science that provides the development applicable to any other area of knowledge and essential to understand the world and the individual culture [27]. Its importance in everyday life and the education of citizens is unquestionable [3], integrating numerous courses syllabi, in higher education. Despite this fact, the school and even educational failure motivated by mathematics is a current controversy [4], [5]. Beyond the gap between higher education and secondary education stand out as causes of school failure factors related to the lack of mathematical thinking skills [4] and motivation [5]. Regarding the problem of school failure in mathematics, some strategic measures, involving technologies, were implemented at the teaching and learning levels [5], [6], [7], [8]. In fact, according with Kanuka & Anderson [28], the technologies allow to create individual and personalized environments, tailored to each one, providing to students the opportunity to experience and to develop their own learning.

Among the various technologies, the online technologies allow to manage information faster and in a more diverse way, and contribute to obtain an education and learning with quality [24], [25], [26], including in mathematics [6], [7], [8]. Such technologies may be an opportunity for achieving changes in teaching and learning, providing the creation of virtual learning environments (VLE) and allowing students to use more attractive media, making them more active and involved in exploring mathematical ideas [7]. For several authors [6], [8], the learning platforms can play a role in the resolution of such problems and may give a significant contribution in combating mathematics failure. In this perspective, some platforms have been developed, in order to support learning in mathematics: for example, the underlying Mathematics Teaching Project – PmatE [6] of University of Aveiro; and iMática of the Institute of Mathematics and Statistics, University of São Paulo in Brazil [8].

Focusing on the same [6], [8] studies, it have allowed to conclude that it may constitute an added value in the learning process of students because, besides allowing to simultaneously managing the mechanisms of learning in formal and informal context, also enables the development of capabilities, autonomy and attitudes as the interest in mathematics.

Also in the School of Technology and Management, Polytechnic Institute of Viana do Castelo, a platform called Platform M@t-educate with success (pM@T) [9] was developed, under the “Educate to Success” project, included in the Operational Programme Science and Innovation (POCI 2010) with the aim of contributing to the struggle against school failure in mathematics, which was the target of this study.

3 METHOD

In order to study the pM@T platform potential, we developed a study that aims to evaluate the influence of previous exploration of this platform, as part of the thematic learning methodology of Integral Calculus: i) in the construction and application of knowledge built; ii) the development of autonomy, manifested by the ability of students in regulating their learning and iii) the development of mathematical interests, manifested by the attitude expressed by the students in relation to the course.

3.1 Methodological options

From the purposes here presented, it is inevitable a detailed study on the use of pM@T platform by students in a real context. Given the complexity of the object of study, in order to better understand it, we opted for a mixed research approach [29] and the case study design [30], since it allows to study in a detailed manner, a particular phenomena in the real world, using multiple sources of evidence (qualitative and quantitative).

3.2 Participants

The study took place in the second semester of the school year 2010/2011, in normal academic environment of the Infinitesimal Calculus course, 1st Year of Management Degree. 50 students attending this course were considered. Among these students, 19 were in a class of the first author of

this article and another 31 were students from a teacher who also used the pM@T platform and followed the same methodology of teaching and learning. To do this, the teacher provided weekly lesson guides and discussed the activities to be developed in the classroom. Thus, all students had to do the same activities inside and outside the classroom.

According to a preliminary questionnaire, it was found that most students chose this course as his 1st choice; they had laptop and had acceded to the internet from home. However, most did not know teaching and learning platforms, and assumed not know about their importance. With regard to mathematics, most students considered themselves weak and unmotivated. However, most of them pointed that mathematics is “important” or “very important” to their training.

3.3 Techniques and analyzing tools

In this study and in order to give it credibility and robustness, we chose a variety of techniques for data collection, supported by various instruments [30], [31]. Thus, we focused on cross-examination, by questionnaire, as this type of instrument allows obtaining information about a particular phenomenon, through questions that reflect attitudes, beliefs, perceptions, interests and behaviour of a set of individuals. Two types of questionnaires were applied: at the beginning of the semester (IQ), with the objective of characterizing the students, and at the end of the trial (QF), with the main objective to know the opinion of students about the pM@T platform and to assess the methodology adopted in its exploration.

Furthermore, we used the techniques of observation and document analysis [32] and diverse instruments such as: Records available on pM@T platform; responses to the tasks proposed in the Study Guides and evaluation of learning test, applied in the pre-test, post-test I and post-test II modalities.

3.4 Description of the study

At the beginning of the semester, students were informed about the structure of the course and the thematic unit of Integral Calculus would be under investigation. Before the start of this issue, students answered a characterization questionnaire and carried out a pre-test, which served a dual purpose – diagnostic evaluation and subsequently allowed to evaluate the progress of students, by comparison with the results of the post-tests. In the first lesson of this thematic unit , students were elucidated that would have to respond to weekly tasks proposed in the Study Guides (SG), provided on Moodle platform and, in the classroom of the following week, those tasks would be discussed with the students, who should already have pre-explored them, when performing tasks of various kinds. This would allow assessing the ability to apply the knowledge constructed by autonomous and self-regulated exploitation of pM@T platform. It was indicated also that the practice component assessment of this thematic unit would be subject to the timely delivery of replies to all SGs. During this study, we used four study guides: the first study guide (SG_I) on the concept of definite integral and indefinite integral, immediate integration and almost immediate and full implementation of the calculation of areas of plane figures; the second (SG_II) on immediate integration and almost immediate, considering exponential and logarithmic functions, direct and inverse trigonometric functions and integration by substitution; the third (SG_III) on integration by parts and integration of rational functions and the fourth (SG_IV) on other applications of definite integrals, such as lengths of lines, areas of surfaces of revolution, volumes of solids of revolution and improper integrals.

During the study, the students had about a month to solve individual tasks of a different nature, which subsequently were discussed at the level of the class. Thus, the autonomous execution of tasks and the use of the study guides available on the pM@T platform were promoted.

At the end of the thematic unit, the post-test I was performed and an opinion questionnaire on pM@T platform was applied. A month later, took place the post-test II.

3.5 Data processing

Given the various techniques and tools used for data collection, we got a considerable amount of information and made use of different data analysis methods, both qualitative and quantitative. Quantitative data was subjected to statistical analysis, initially using the descriptive statistic and then, the inferential statistic, allowing extrapolation to the general population. Qualitative data was subject to qualitative content analysis of categorical type [39] primarily focused on autonomy, in the knowledge construction and application and on interest in mathematics.

4 DATA ANALYSIS

According to the information available on the platform, most students (88%) used it, having been recorded 174 sessions. In 120 sessions, students acceded to dynamic guides and in 112 sessions acceded to the digital guides. The number of accesses per student ranged from 0 to 10, deviating from the expected, because it was expected that each student perform at least one session per week, which accounted for 4 sessions per student.

4.1 Autonomy

On average, students held 4 sessions, 18 having made 4 or more sessions. It appears also that the number of sessions decreased over the implementation period of this study. Although most students have indicated not to know teaching and learning platforms and disregarding its importance, we found that students were able to use the pM@T platform without help of the teacher. There was a greater adherence in the 1st week (78% of students) and a lower one in the last two weeks (both equal in 36% of the students) and some students continued to use it after the study conclusion (7 students). It should be noted that several factors may be balanced against the reduction in the number of sessions on the platform along the experimental step. On the one hand, the increasing workload and on the other hand by the fact that students can make downloads of digital guides.

During the four weeks on the experimental step, it was found that the delivery volume of study guides was very close, except during the first week (Table 1). It should be noted that that the first task of many GE_I did not require prior knowledge of mathematics.

Table 1: Average number of study guides delivered, initiated tasks and tasks correctly performed (%).

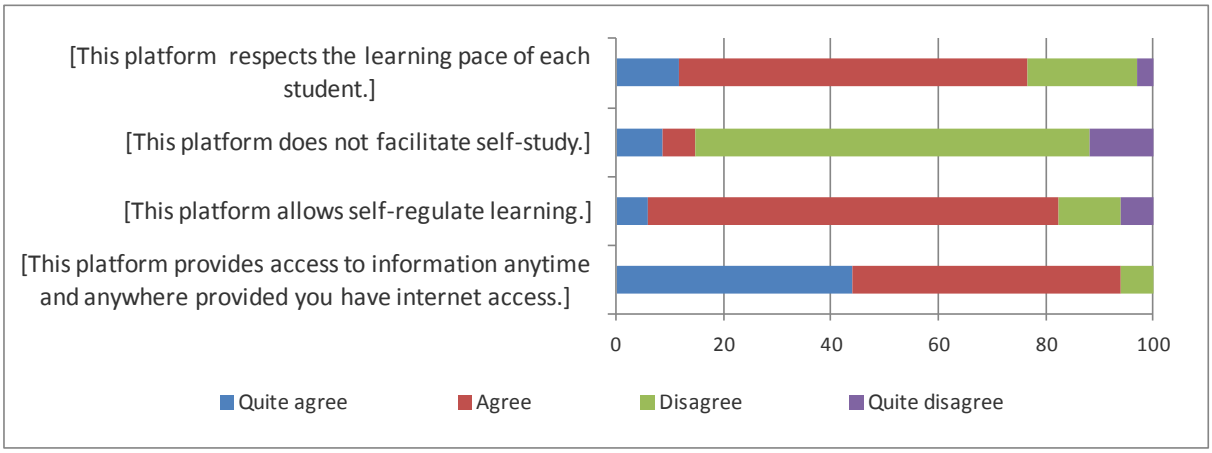
	SG_I	SG_II	SG_III	SG_IV
Study Guides Delivered	76	68	66	66
Attempts to Answer	61	51	55	43
Correct Answers	42	33	36	35

The completion of the subsequent study guides was more demanding in terms of mathematical knowledge, which may have contributed to the decrease in the number of study guides deliveries.

Since the delivery of the study guides was mandatory, even if students had not performed any task, all study guides were analyzed. According to Table 1, it appears that the SG_I has the highest percentage of attempts to answer (61%) and SG_IV the lowest percentage (43%), which may be related to the reasons given above – the mathematical complexity of the tasks. On the questions whose answers were correct, it was found that, on the average, students correctly answered 37% of the tasks that were proposed to them in the study guides. In the first two study guides, the average percentage of correct responses decreased, which may be related to the degree of difficulty of the tasks proposed in the study guides. Regarding SG_II and SG_III, the average percentages of correct responses increased, which may be related to the fact that students have acquired mathematical knowledge, as well as increasing the powers of exploitation of content on the platform. It should be noted that despite the increased complexity of the proposed tasks, the percentage of correct responses decreased very slightly from SG_III to SG_IV.

Analyzing the results of the tests implemented in three different moments, it was found that most students did not try to solve tasks in the pre-test, mobilizing previously acquired knowledge. It should be noted that from the pre-test to the post-test, all students tried and, in some cases, were able to solve more tasks. Thus, it denotes that they developed the ability to apply what they have learned, which have not been disconnected from the development of the autonomy capacity.

Finally, considering the responses to the review of the platform questionnaire, it was found that the majority of respondents (86%) disagreed that this platform does not facilitate self-study (Graphic 1). Also, the majority of the students chose to agree that this platform allows self-regulate learning (82%) and respects the learning pace of each student (77%). However, the same percentage of students (6%) disagreed and agreed quite well that this platform allows self-regulate learning.



Graphic 1: Influence of pM@t platform concerning autonomy development (%).

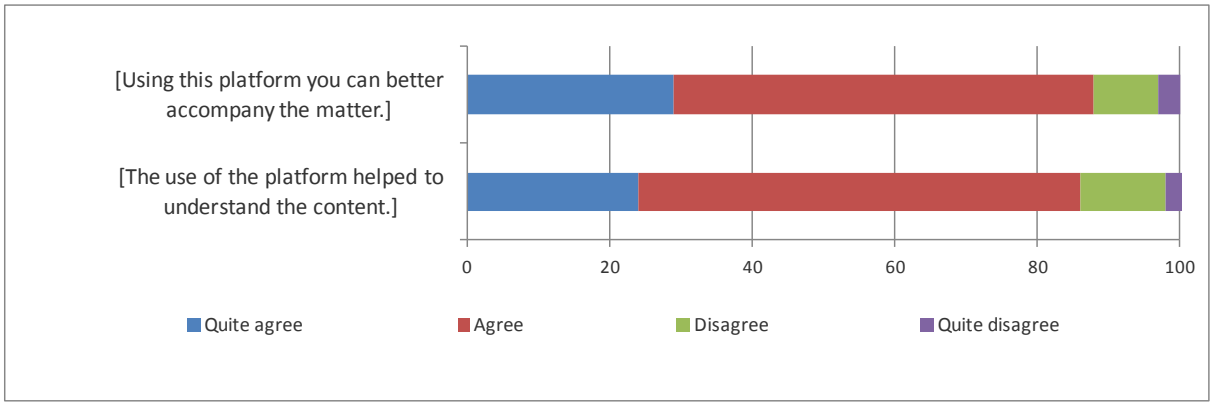
Regarding the analysis of the last question on the strengths and weaknesses of the platform, it is noteworthy that most of the answers lies in the category: Impact of the platform on student learning, and within this, the subcategory with more units of meaning is related to the promotion of knowledge construction, then the subcategories related to the promotion of understanding and development of autonomous learning.

4.2 Knowledge construction and application

Analyzing the content of responses to the tasks of the study guides, it was found that about 37% answered correctly to the proposed tasks in the various study guides (Table 1). Thus, students proved to be able to build and to apply some knowledge, even when the contents were not previously introduced by the teacher. It is important to note that the tasks proposed in these study guides were not a mere repetition of tasks explored on the platform.

Regarding the results obtained in the three different evaluation periods, it was found that all students had better marks in post-tests. It may be concluded that there was acquisition of knowledge in this subject and that they learned to apply it. Comparing the average of the marks obtained at the three tests application (pre-test = 0.2 points; pre-test I = 9.3 points and pre-test II = 9.2 points) it appears to be an increased from pre-test to post-test. The same was true regarding minimum grades: pre-test = 0 points; post-test = 1 point and post -test II = 3.3 points. Considering the top marks, it was noted: in the pre-test = 3.5 points; at post-test I = 19.3 points and post -test II = 14.9 points. Looking at the average of the absolute gains, it has 9.1, 9.0 and 4.3 points, respectively, from pre-test to post-test I, pre-test to post-test II and post-test I to post- test II. From the post-test I to post-test II, the average of absolute loss is 3.0 points. The average of the relative gains from pre-test to post-test I, the pre-test to post-test II and post-test I to post-test II are respectively 46.0%, 44.2% and 29.4%. With respect to the relative losses from post-test I to post-test II, it was found that the average of -23.1%. The performed analysis leads to admit that there was an increase in student learning, and using the Friedman test it was found there are significant differences between the results from the pre -test to the post-tests. It was also found, by calculating the Spearman correlation coefficient, the existence of a correlation between the delivery of the study guides and the post-test marks. The same was not observed between the post-test and the pre-test II.

From the analysis of the opinion questionnaire about the pM@T platform, and from a global assessment of the platform (Graphic 2) it was found the majority of students (88%) agreed with this platform, saying that it allows to follow the taught contents, 29% having quite agreed with that. 85% of the students agreed that the use of the platform helped to understand the contents, and 24% quite agreed with that.



Graphic 2: Assessment of Calculus students to the questionnaire on the platform with a focus on issues in the construction and application of knowledge (%).

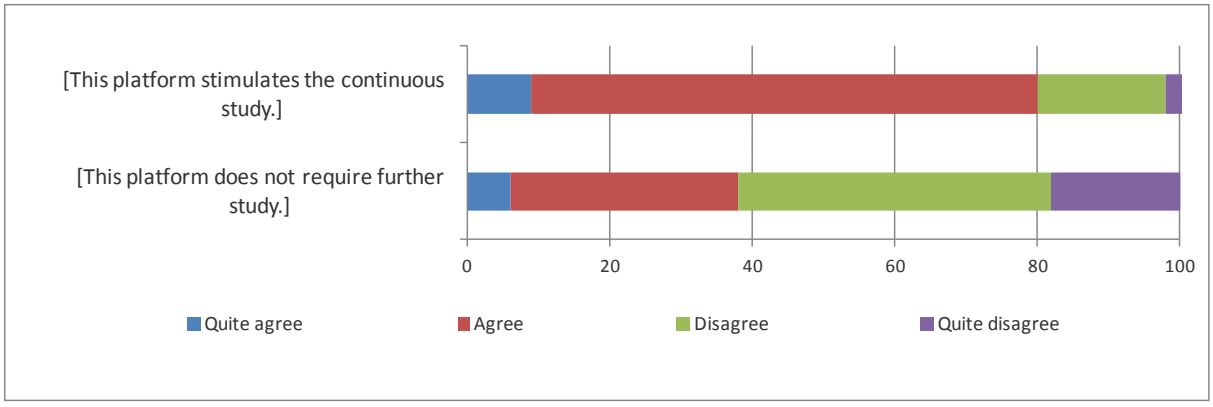
Regarding the last question of this questionnaire about the identification of strengths and weaknesses of the platform, students stressed its contribution in the learning process.

4.3 Interest

After analysing the study guides received over the weeks, it appears that the number of students that submitted them decreases slightly from first to second week, and also from second week to the third week. It remained constant from the third to the fourth week (Table 1). However, the number of solved tasks decreases from the first to the second week and from the third to the fourth week, and increased from the second to the third week (Table 1). Thus, it appears that some students gave up their review of this component, showing a lack of interest in trying to approve this course, having these alleged lacks of bases.

However, 69% of students, on average, were submitting the weekly study guides. Moreover, looking closely at the last study guide of the study, it appears that, despite have been one of the study guides with fewer deliveries (66%), the percentage of students who did not attempt to answer any question was 25%, 63% having attempted to answer 50% or more of the tasks, 22% of the students tried to answer to 75% of the tasks and 9% of the students tried to answer to all tasks.

Considering the responses to the opinion questionnaire about the platform as to it influence the studies of the students (Graphic 3), the majority of the students (62%) disagreed with the statement “this platform does not require further study”, having chosen quite disagreed (18%). However, 80% quite agreed or agreed that “This platform stimulates the continuous study”.



Graphic 3: Students’ opinion on the influence of PM@t in promoting Maths study (%).

Finally, analyzing the contributions of the students concerning the identification of strengths and weaknesses of the platform, with respect to the interest in mathematics, particularly its study, it was found that the majority recognizes the potential of pM@T platform. Most students think that this platform enhances learning, considering that helps them in their studies and facilitates understanding of the content covered, including in the classroom.

5 CONCLUSIONS

In the beginning, the majority of students were not familiar with teaching and learning platforms and did not recognize its importance. However, most managed to explore the pM@T platform on their own, without the help of the teacher. The number of weekly sessions held on the platform decreased in the two last weeks. The volume of deliveries of study guides was higher in the first week. Students' performance in the study guides was not constant throughout the experimental period. It was found that the number of attempts to answer is almost always decreasing from week to week. However, one cannot overlook the increased complexity of the proposed tasks and the increased workload inherent in the course of the semester. The results of the test in three different moments reveal a change in the attitude of most students. In the pre-test, most students did not try to solve any task, which did not occur in subsequent times. It was also observed that in the post- tests, most sought to answer, taking on certain tasks, shown ability to apply what they had learned, which was reflected in the marks obtained by the students. From the analysis of the opinion questionnaire on pM@T platform, applied in the end of the study, it was found that most students recognized that the platform is an asset for the study, supports the learning, helping in understanding the content and facilitating the construction of knowledge.

Analyzing the contribution of content exploitation of the pM@T platform, before being formally addressed in the classroom, as part of a methodology for learning mathematics, to develop autonomy capabilities, it can be said that although most students have indicated not use or know of specific mathematics teaching platforms in the "Characterization of the students" questionnaire, it was found that there was voluntary access to the pM@T platform, even after the end of the study. This adherence is in agreement with the analysis performed by the students at the end of the experimental study, recognizing that the platform encourages continuous study, allows self-regulated learning and facilitates self-study, meeting the concerns of Kanuka & Anderson [28].

Regarding the dimension of knowledge construction, although students have shown at the beginning of the study, very few knowledge about the theme of integral calculus, it was established through the study guides, an evolution of their responses over the four weeks of implementation of the study. Moreover, the performance of students in post-tests was an evidence of this. From the analysis of opinion about the platform, we found that students recognized that the use of the platform helped them to understand the contents. Students' recognition of the contribution of this platform, as well as the methodology adopted in the construction of knowledge, leads us to ponder the importance of this platform in the teaching and learning of mathematics, in particular, in this case, the study of Integral Calculus. These results are consistent with the theoretical perspectives that advocate the potential of using learning platforms in promoting the construction of knowledge in mathematics [6], [7].

Regarding the other dimension, it was found that students felt that this platform enhances the interest, the majority considered that the methodology makes it easier to follow face-to-face classes and that the platform was helpful, although there is no clear evidence of change in attitudes towards the study of mathematics.

In this sense, it can be argued that the methodology, which supported the use of the pM@T platform was positive, because the analysis of the results revealed that students recognized the importance in using this platform, particularly in the topic of Integral Calculus. Students felt that this platform was an asset for the study, acknowledging that it was a facilitator and promoter of learning, as already revealed in the study by Barreira [5].

These results confirm the importance of using technology as a complement to students' learning process [5], [6], [7], [28], strengthening the construction of knowledge, the development of autonomy and skills related to mathematics and students' interest in relation to this area.

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